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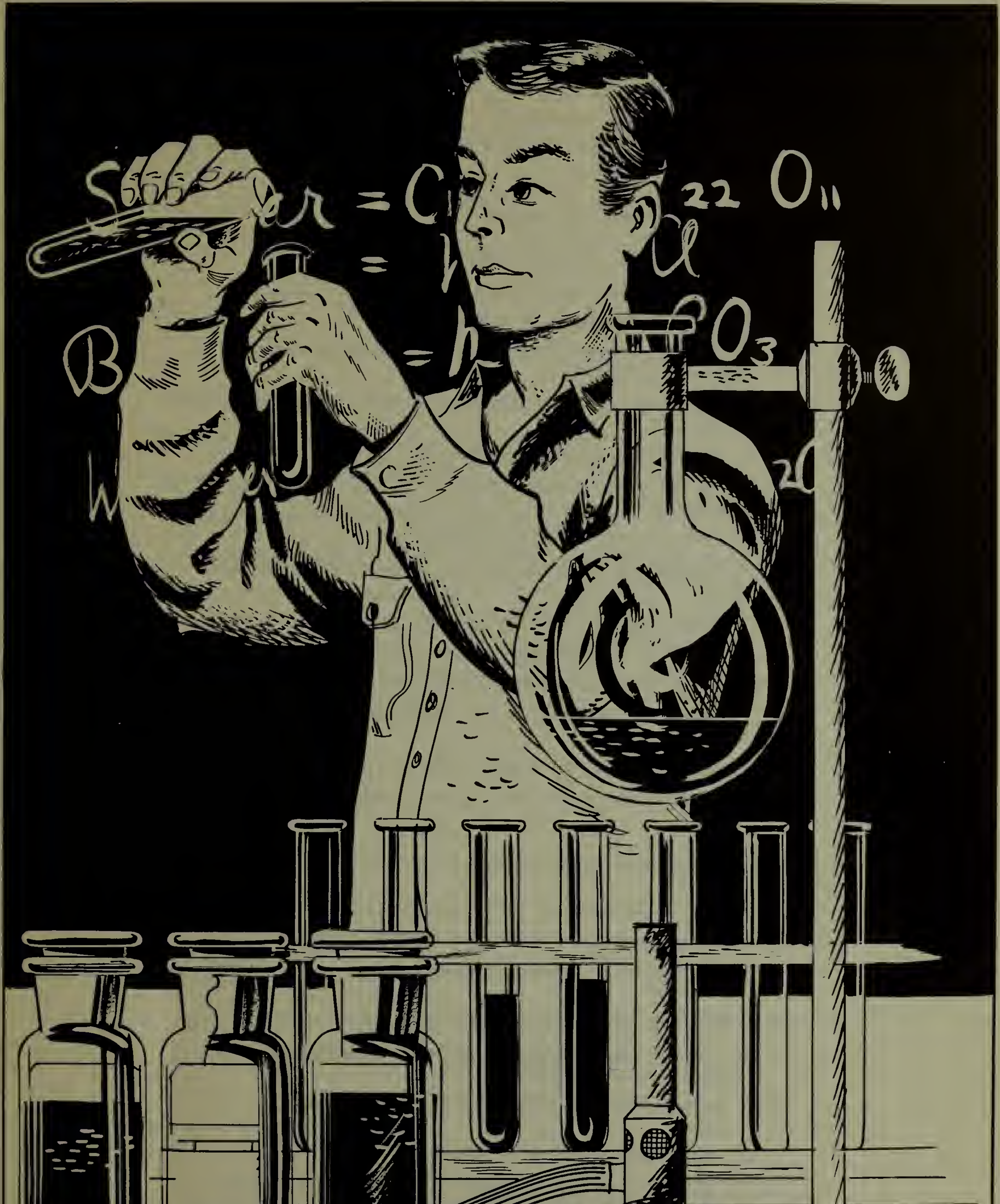
Grade IX
Curriculum Guide

for

SCIENCE

1959

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF EDUCATION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Acknowledgement

The Department of Education acknowledges with appreciation the contributions of the following committee members to the preparation of this curriculum guide for Junior High School Science.

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PREFACE

The reaction to the Grades VII and VIII science guide, introduced in 1959, was favorable. Therefore the design of this guide, the Grade IX edition, follows the pattern set in 1959. In addition, much of material preliminary to the actual unit outlines has been reproduced from the Grades VII and VIII guide.

In the unit outlines the policy of strengthening the course content has been carried forward from the 1959 guide, and the emphasis on experimentation and demonstration has been continued. Also, the practice of listing aids and references in detail has been retained.

In September, 1962, a new edition, consisting of the outlines for Grades VII, VIII and IX, will be authorized.

Primary Considerations

What is Science?

Science has two meanings: first, it is a body of organized knowledge; secondly, science is a method of solving problems.

There are many sciences or organized bodies of knowledge such as physics, chemistry, botany, zoology, geology and mathematics. Each has its own set of facts and its own technical vocabulary. All have the scientific method in common.

Why Teach Science?

Science teaching should begin with the consideration of facts. However, when this has been done the task has just begun. The facts must be used to lead the pupils to an understanding of scientific principles and to the development of generalizations.

Along with this there should be the development of: a scientific attitude, skills, habits, the ability to solve problems scientifically and an appreciation of the contribution of scientists.

What is the Scientific Method of Solving a Problem?

The scientific method is an organized plan for solving a problem. Here are the essential steps:

(1) The scientist first defines the problem. He usually lists what he knows about the problem and then isolates the unknown factor or factors in the light of all the known facts.

(2) The scientist next formulates a hypothesis.

(3) The next step is to test the hypothesis by experiment. If the experimentation fails to verify the hypothesis it is discarded and a new one is set up. The process is then repeated until the hypothesis seems to be true. The hypothesis is usually accepted as valid when a number of experiments support it.

(4) The final step consists of checking the tentative conclusion with the results obtained by other scientists.

What is the Scientific Attitude?

These characteristics are commonly associated with one who has a scientific attitude:

(a) He has an INQUIRING MIND.

(b) He is CAREFUL and ACCURATE in his work.

(c) He is IMPERSONAL in his attitude towards a problem; he is unswayed by superstition and prejudice.

(d) He is OPEN-MINDED. His hypotheses are discarded or altered if they do not agree with new facts.

(e) He is CRITICAL. He continually asks himself questions such as “Can I rely on these facts? What is their source? Am I equally critical of my own thinking?”

(f) He is SKEPTICAL although he respects the work of experts.

Making Science Teaching More Effective

Science teaching can be made more effective by applying the following principles:

1. The teaching should begin where previous experience and learning have left off and should take into account the needs of the pupils.

2. The teacher must establish definite goals within each unit. Interest may be aroused by discussion, questions, visual material, the posing of problems and relating the work to the students' own experiences.

3. Teaching is most effective when the pupils are encouraged to do their own thinking. Scientific principles cannot be taught as facts to be memorized, but must be a product of the pupils' own mental processes. Pupil experiences should be centered about specific generalizations which will be arrived at largely by careful observation and conclusion on the part of the pupils themselves.

4. The more the facts and laws learned are applied, the better they are understood and the more likely they are to be retained. (This principle of use is an extension of number three.) The frequent consideration of problems and exercises involving the generalizations previously learned reinforce understandings.

5. A good science teacher realizes the importance of reading and assumes a two-fold responsibility in this regard:
   (a) Abundant free reading in the field of science should be made available. This is in addition to the regular secondary reference material.
   (b) In order to read with understanding a pupil must have an adequate knowledge of the vocabulary of science. Every science teacher should make certain that attention is given to teaching this vocabulary.

6. Science teaching is more stimulating and challenging when pupils are encouraged to work at first hand with the materials of science. **Experiments and demonstrations are an essential part of any science program.**

Perspective

To be more effective, a teacher of science must know how the work at hand fits into the total picture. Needless repetition of work covered previously by a class will be avoided by a teacher who is familiar with what has been taught in the preceding grades. Also, if a teacher knows what is to be offered to the class in succeeding grades, problems resulting from carrying a unit of study too far can be avoided.

Teachers should familiarize themselves with the science curriculum outline for each of the elementary, junior and senior high schools.

To help teachers obtain a proper overall picture of the science program summaries or "grids" for elementary, junior and senior high schools are included in this course outline. Staff meetings or consultations to familiarize teachers with the science programs at all levels are strongly recommended. It has been established that if these meetings are held early in the fall they will be of maximum value.

The term "Suggested Treatment", that heads one of the four columns in the outline of each unit, needs clarification. The purpose of the information given under the heading is to acquaint teachers with *one* method of presentation recommended by experienced teachers. The presentation is primarily intended for beginning teachers and for others whose area of specialization is other than science. It must be emphasized that the treatment is *suggestive,* but *not prescriptive.*

		GRADE I	GRADE II	GRADE III
LIVING THINGS	(a) Animals	Environment, homes, food, used by men for various purposes, prepare for winter.	Must have food to live and grow. Baby animals receive varying degrees of parental care.	Have structures that enables them to get food in many environments. Should be conserved by man.
	(b) Plants	Live in various places, are used by people and animals in various ways, prepare for winter.	Need light and water to grow. Seeds, travel in many ways.	Have roots and leaves to get food. Have enemies that can destroy them. Are protected by man.
	(c) Conservation	Wild life	Forests as homes, for animals. Respect for birds' nests. Care of plants by controlling insects, by wise use of water and general care.	Care of plants and animals as mentioned above.
THE EARTH AND THE UNIVERSE		Weather—From day to day Through the seasons.	What We Can Learn From the Sky— Directions. Moon changes. Kinds of clouds.	The Earth We Live On— Interesting geographic features. Rocks, soil and plants. Use of maps and globes.
		What we see in the sky— Sun, moon, stars, clouds.	What Are the Causes of Weather— Wet weather. Heat from the sun. Wind.	Wonders in the Sky— Sun, moon, stars.
		What we see on the earth around us— Rocks, land, water.	Thermometer— Enrichment Material How it works, what it tells us, and how it helps us.	The Air Around Us— Part of earth, found in soil and water, takes up space.
		Air is all around us— We can feel it. It moves things.	Conservation—Protection of toys from weather. Protection of soil against drifting.	Conservation—Water erosion and conservation of soil.
ENERGY AND MACHINES		Machines—Help us to do work easily and more quickly. Should be well cared for.	Work—Requires energy which comes from many sources.	Wheels and Levers— Use, operation.
		Magnets—Do strange things.	Machines—Use of rollers, wheels and ball bearings.	Using Magnets and Electricity— Poles, compass needle, dry cell, wires, light bulbs, switches.
			Fun With a Dry Cell— Suggested enrichment.	
			Rust—Suggested enrichment.	
		Conservation—Care of machinery.	Conservation—Protection of machines.	Conservation—Care of machinery.

ELEMENTARY SCHOOL SCIENCE

GRADE IV	GRADE V	GRADE VI
How Living Things are Grouped Living and non-living. Plants and animals. Seven groups of animals. Two groups of plants.	**Where Do New Plants and Animals Come From and How Do They Grow?** Mammals, birds, amphibians, etc. Plants grow from seeds, roots, stems, leaves, grafting, spores.	**Interdependence of Living Things** Animals and animals. Plants and plants. Animals and plants.
How Some Plants and Animals Make us Sick Tiny plants and animals called germs. Some bacteria cause disease, others are helpful. Bacteria are everywhere and multiply very fast.	**Where Plants Grow**—Enrichment suggestion.	**What is the History of Living Things?** Earth long ago. Fossils. Plants and animals have changed. Importance of ability to adapt. **Fish Life**—Enrichment.
Why Do All Living Things Need Air and Water? Animals and plants need oxygen to breathe. Plants use carbon dioxide to make food. Plants need water to dissolve food. Animals need water to make digestive juices and the liquid part of the blood.		
Conservation—Care of trees. Feeding birds in winter.	Conservation—Living Things. Forests.	Conservation—Wild Life. Soil.
The Earth—Its shape, spins on its axis, travels 'round sun. Has a blanket of air which is a mixture of gases, pressing on all things. Man uses this pressure. Has soil on its surface essential to plants and animals. Contains valuable rocks and minerals.	**What is the Universe Like?** Solar system, comets, eclipses, beyond the solar system, birth of our earth. **Changing the earth's surface.**	**Weather and How We Forecast It** Rain, Hail, Snow, Sleet, Wind. **The Milky Way and Beyond.** **Our Earth**—A huge Magnet. **The Earth's Airways and Beyond.** **Why The Seasons Change.** **Animals and Seasonal Changes.**
Conservation Using Materials Wisely.		
Static Electricity Charging objects, behavior of charged objects, lightning, thunder. **Current Electricity** Uses, current coming into homes, safety of using dry cells in experiments, conductors, insulators. **Our Body Is a Machine** Muscles move, bones and joints are levers, food provides energy. **Machines Help Man by Using Air Pressure** Electrical energy and energy from coal, petroleum, natural gas.	**Electricity**—Production and Control. Current electricity, frictional. How current flows. Why wires are covered. Production of heat, light, magnets, telegraph keys, electric bells. **Effect of Heat and Cold on Materials** Heat travels, effect of heat and cold on gases, liquids, solids. Heat and cold cause changes in gases, liquids and solids. **What Things are made of** Elements, compounds, molecules, chemical changes, facts about elements. **How We Control Fires** Materials to make fire, what happens when things burn, conserving fuels, preventing fires, putting out fires.	**How Machines Can Fly** Man's observation of birds, insects, animals, seeds. Gliders, airplanes with motors, jet airplanes, safety in air travel. **How Machines Help Us To Do Work** Work, levers, inclined planes, pulleys, wheel and axle, making machines work better, safety around machines. **What is Sound and How Does it Travel?** Making sounds, how they travel, different sounds, controlling sounds, musical instruments, how our ears work. **What We Know About Light** Where it comes from, how it travels, how we see, mirror, lenses, how our eyes work, color in light, proper lighting.
Conservation Using Materials Wisely.	Conservation—Prevention of Fire. Conservation of Heat.	Conservation—Care of eyes and ears.

Junior High School Science

Grade VII

I. Plants, Fall Activities

1. Importance of plants
2. Parts of a plant
3. New varieties of plants
4. Wheat
5. Gardening
6. Flowers for the home and schoolroom
7. Common Alberta flowers
8. Plants and clothing

II. Earth's Crust

1. Age of the earth
2. Structure of the earth
3. Classification of rocks
4. The changing earth
5. Evidence of pre-historic life
6. Kinds of fossils
7. Geological eras, periods and epochs
8. Four important geological eras

III. Soil and Erosion

1. Importance of soil
2. Composition of soil
3. Soil forming agencies
4. Water and air in the soil
5. Soil fertility
6. Soil erosion

IV. Water

1. Importance of water
2. The water cycle
3. Hard and soft water
4. Water purification
5. Conservation of water

V. Plants, Spring Activities

1. Trees and conservation
2. Seeds and germination
3. Gardening
4. Improvement of grounds
5. Plant enemies

Grade VIII

I. Animals

1. Comparing plants and animals
2. Invertebrates
3. Vertebrates
4. Necessity for conserving wildlife
5. Methods of conserving wildlife
6. Young people and conservation

II. Weather

1. Weather and climate
2. Air pressure and weather
3. Winds and weather
4. Water vapor and weather
5. Clouds and weather
6. Weather forecasting

III. The Solar System

1. Early ideas about the universe
2. Present ideas about the solar system
3. The sun
4. The earth
5. The moon
6. The planets
7. Astronomy and the stars
8. Smaller objects in the solar system
9. Stars of many kinds
10. Artificial satellites and looking to the future

IV. Magnetism and Electricity

1. Magnets

2. Electricity at rest and in motion
   Static electricity
   Magnetism and electricity
   Uses of electromagnets

3. Producing and Using Electricity
   Generators and motors
   Power plants
   Electricity in the home
   Heat and light from electricity
   Communication

V. Domestic Animals

1. Using and improving domestic animals
2. Cattle—Dairy and beef cattle
3. Livestock for power, fibre and food
   Horses, sheep, swine, poultry and honey bees

Grade IX

I. Introduction
  1. What is science?

II. Machines
  1. Measurement
  2. Force, work and power
  3. Simple machines
  4. Levers
  5. Energy
  6. Gases and the kinetic theory
  7. Properties of liquids
  8. Pumps and buoyancy

III. Combustion and Fuels
  1. Oxygen and hydrogen
  2. Fires and their control
  3. Coal
  4. Oil and natural gas
  5. Carbon dioxide

IV. Heat and Temperature
  1. Effects of heat
  2. Transmission of heat
  3. Temperature
  4. What is heat?
  5. Evaporation of liquids

V. Light
  1. Illumination
  2. Effects of light
  3. Optical instruments
  4. What is color?

VI. Transportation
  1. Steam engines
  2. Internal combustion engines
  3. Aircraft
  4. Jets, rockets and missiles

Senior High School Science

Science 10

CHEMISTRY SECTION

I. Outline of the Story of Science

1. Our debt to the past
2. Emergence of the Scientific Method of study

II. Some Fundamentals

1. Classification of matter
2. Composition of matter
3. Structure of matter

III. Shorthand of Chemistry

1. Symbols and formulae
2. Equations

IV. Oxygen and Three Important Classes of Compounds

1. Oxygen, the world's most abundant element
2. HCl, a typical acid
3. NaOH, a typical base
4. NaCl, a typical salt

PHYSICS SECTION

I. Mechanics of Fluids

1. Molecular forces in liquids
2. Pressures in liquids at rest
3. Pressures in gases
4. Fluids in motion

II. Heat

1. Heat and temperature
2. Expansion of solids
3. Expansion of liquids
4. Expansion of gases
5. Specific heat and thermal capacity
6. Latent heat
7. Experiments on heat

Science 20

PHYSICS SECTION

A. Mechanics

I. Measurement
II. Density and Specific Gravity
III. Buoyancy
IV. Force, Work and Power
V. Experiments on Mechanics

B. Light

I. Nature and Propagation of Light
II. Photometry
III. Reflection of Light—Mirrors
IV. Refraction of Light—Lenses
V. Color
IV. Optical Instruments
VII. Experiments on Light

CHEMISTRY SECTION

I. Solutions

II. Chemical Classification

1. Law of conservation of mass
2. Law of definite proportion
3. Elements and compounds
4. Mixtures and solutions

III. The Gas Laws

1. Standard pressure
2. Boyle's Law
3. Absolute temperature
4. Charles's Law
5. Standard temperature

IV. Laws and Theories

1. Equivalent weights
2. Law of combining weights
3. Law of multiple proportions
4. Gay-Lussac's Law
5. Dalton's theory
6. Avogadro's Theory

V. Symbols, Formulae and Equations

VI. Valence

VII. Naming Compounds

VIII. Using Equations

1. Calculating relative weights
2. Weight-weight problems
3. Weight-volume problems
4. Volume-volume problems

Physics 30

A. Mechanics
  I. Velocity
  II. Acceleration
  III. Newton's Second Law
  IV. Newton's Third Law
  V. Work, Energy and Power
  VI. Machines and their Efficiency
  VII. Composition and Resolution of Forces
  VIII. Moment of a Force, Center of Gravity
  IX. Friction

B. Heat
  I. Heat and Temperature, Thermometers
  II. Expansion of Solids
  III. Expansion of Liquids
  IV. Expansion of Gases
  V. Specific Heat, Thermal Capacity
  VI. Latent Heat

C. Electricity
  I. Electrostatics
    1. Electrification by friction
    2. Electrification by induction
    3. Electrostatics units
    4. Potential

  II. Chemical Effects of the Electric Current

  III. Current Measured by Its Magnetic Effects

  IV. Ohm's Law and its Applications

  V. Electromagnetic Induction

  VI. Electricity as Energy

Chemistry 30

I. Review
  1. The gas laws
  2. Laws and theories
  3. Symbols, formulae and equations
  4. Valence
  5. Naming compounds
  6. Using equations

II. Ionization, Acids, Bases and Salts

III. Carbon and Its Compounds

IV. Fuels and Flames

V. Sulfur and Its Compounds

VI. Salt and Its Place in Industry

VII. The Halozens

VIII. Periodic Classification of the Elements

IX. The Alkali Metals

X. Compounds of Nitrogen

XI. Calcium and Magnesium

XII. Chemistry in Industry

XIII. The Metals
  1. Activity table
  2. Oxidation and reduction
  3. The spectroscope
  4. Metallurgy

XIV. Aluminum

XV. Iron and Steel

XVI. Copper

XVII. Organic Chemistry

XVIII. The Chemistry of Foods

XIX. Chemistry and the Future

Experiments and Demonstrations

In any experiment there is a problem to be solved. Sometimes the problem may be to verify the results obtained by scientists, but there is still an element of discovery present because the outcome is not fully known beforehand. Some typical verification experiments are:

(a) finding the weight of a volume of air.
(b) determining the effect of like and unlike magnetic poles on one another.

Experiments that fail to verify known results should not be considered failures in the educational sense. Analysing the experiment and finding where it went wrong might develop the knowledge and thinking of a class as much as watching a successful verification.

As often as possible actual problems that exist should be solved by designing and carrying out pupils' experimental procedures. The problems to be answered might be of this type:

(a) Which expands more when heated, iron or aluminum?
(b) Do moist iron filings rust faster in air or in oxygen?
(c) What is the relative humidity of the air in the classroom?

A demonstration differs from an experiment in that it is conducted by an "expert" who already knows what the outcome will be. The expert may be a teacher or a pupil, who under supervision, previously conducted the activity as an experiment. In the demonstration the expert is repeating the activity and attempting to lead others to the same conclusions reached in the original experiment.

Usually, a demonstration is conducted by one or more demonstrators in the presence of several observers. In an experiment small committees are usually working without spectators.

Experiments and demonstrations are not ends in themselves; their purpose is to encourage scientific thinking on the part of the class. Though the generalizations to be learned are prescribed, the experimental work leading to these may be flexible. Different experiments may be used from year to year and frequently a teacher should set groups working on different experiments, each leading to the same goal.

The recording of an experiment is a valuable experience for pupils but is of secondary importance. There should be rather complete notes on a few of the key experiments, but on minor experiments and demonstrations a brief note on each will suffice. The most important parts of an experiment are the planning, the observation and the critical thinking. Notes copied from a chalkboard or textbook on experiments that have never been performed are of no value to the pupils, regardless of how neat or well-colored the diagrams may be.

It has often been said, and rightly so, that a science course is not a science course unless there is experimentation and demonstration.

Enrichment

The purpose of enrichment in science is primarily to give pupils a better understanding of the generalizations. In other words, the **concepts** are being enriched.

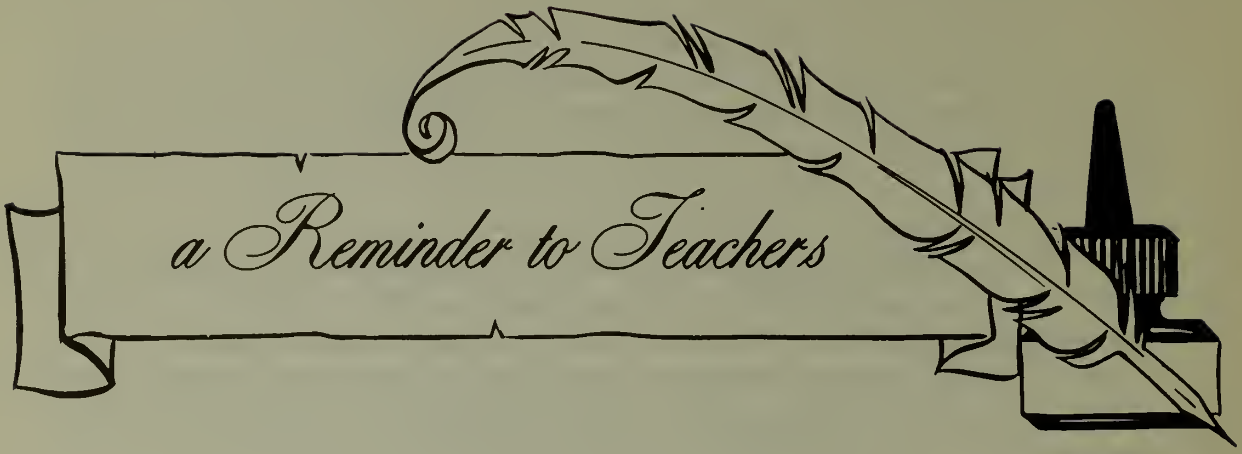
Enrichment can be carried out in two general ways. First, the pupils may be given material beyond the scope of the ordinary subject matter. This is usually termed "vertical" enrichment. Second, the pupils may be given additional experiences within the limits of the areas as outlined in the course. This may be referred to as "horizontal" enrichment.

The first method, actually a variation of acceleration, has definite drawbacks. At the time it may appear satisfactory but subsequent repetition may lead to obvious difficulty. This vertical type of enrichment may be used to advantage in areas that do not occur in a science course to be studied in later grades. In a case of this kind there is no reason why a teacher should not have a group of pupils go as far beyond the course requirements as time, pupil interest and ability permit.

The horizontal method of enrichment is usually the more desirable. Because much of the reading material must come from other than standard texts a teacher is required to become familiar with the science books in the library and also to gather together as much pertinent material as possible from current magazines. In addition, this type of enrichment calls for the fullest possible pupil participation in terms of experiments and demonstrations.

Enrichment is needed particularly by superior pupils who are not sufficiently challenged by the regular course requirements. However, there will be occasions when others of only average ability will become sufficiently interested to warrant enrichment. There is very little point in suggesting enrichment projects to pupils of low interest or low ability.

Finally it must be pointed out that enrichment exercises found in this guide are merely suggestive. They are intended for the teacher who has neither the time nor the specialized training in science to plan additional experiences for special students. The keen science teacher will think of many enrichment activities to supplement those listed. The real key to the selection of enrichment activities is the interest shown by the pupil.



a Reminder to Teachers

Some of the science equipment required for the new Grade IX course was not needed previously, therefore teachers are reminded to check the material listed on page 65 and to order, well in advance, any additional supplies needed.

Many teachers have adopted the wise practice of asking pupils to bring to the classroom discarded material such as the following:

- used thermostats
- old eyeglasses
- small gasoline engines
- automobile parts—
  - water pump
  - carburetor
  - ignition coil
  - spark plug

Throughout the year teachers should collect magazine articles and news items dealing with rockets, missiles, artificial satellites, etc. Material of this nature is needed in the study of Unit V. See Classroom Aids for supplementary materials.

INTRODUCTION

WHAT IS SCIENCE?

The introductory chapter in Basic Physical Science attempts to set the stage for a problem-solving approach to the study of science. Junior High School students should learn the techniques of solving problems scientifically. In order that they may master these techniques, opportunities must be provided for them to deal with new problems developed by the teacher or the class. It is very likely that in the future the Grade IX Departmental Examinations will test the ability of the students to outline methods which might be used in the solution of problems he meets for the first time. An example of this type of problem follows:

PROBLEM:

Does the air around us contain something that causes food to spoil when exposed to it?

The solution of such a problem might be:

Materials:

Some fresh meat, two test tubes with well-fitting rubber stoppers, a tall beaker, retort stand, wire gauze, piece of glass and a source of heat.

Method:

Thoroughly wash and sterilize both test tubes with boiling water. Label them No. 1 and No. 2. Fill each test tube half full of the meat and fit the rubber stopper loosely in the top of each. Now stand both test tubes upright in the beaker which has been partially filled with water and cover the beaker with a glass plate. Heat the beaker and boil the contents for 20 minutes. While the water is boiling remove each test tube and at once force the stopper firmly into No. 1 test tube. Let the stopper remain loosely fitted in No. 2 test tube. After both test tubes have cooled, force the loose stopper firmly into place. Set them in a test tube rack in the classroom. Examine the contents daily but do not open either tube.

Observations and conclusions:

Observations and conclusions cannot be given here since the pupils have not actually performed the experiment.

Pupils should record with considerable care the details that are actually observed, not those that a text or reference states should be observed.

Any conclusions reached should be based on the actual observations.

UNIT I—GRADE IX

MACHINES

References:

Hogg: *Basic Physical Science,* Van Nostrand

Adair et al: *Science, Discovery and Progress,* Clarke, Irwin & Co.

Van Hooft: *Our Environment: How We Use and Control It,* Allyn & Bacon

Lynde: *Science Experiences with Home Equipment,* Van Nostrand

Filmstrips:

Energy and Engines (E.B.F.)

Simple Machines (Curriculum)

Film:

Hydraulics

Laboratory Apparatus and Material:

Meter sticks, with clamps and support
Friction block
Wheel and axle
Model of hydraulic press
Mercury barometer tube
Overflow can
Mercury
Spring balances
Pulleys—single and double
Jack screw model
Test tubes and clamps
Model lift pump
Sulfur
Equal arm balance and weights
Inclined plane board and attachments
Pendulum bob
Burners
Model force pump
Archimedes' Triangle apparatus

Experimenting with Science

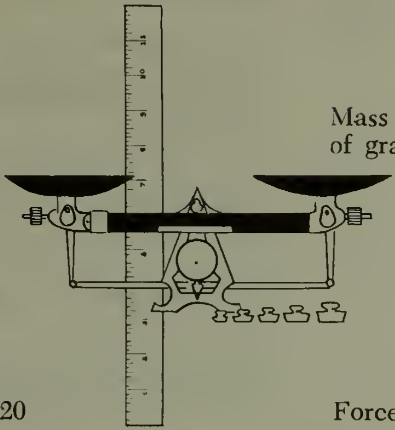
UNIT I

MACHINES

Content	Suggested Treatment
I. Measurement	Discussion or report: The part measurement plays in science.
A. British and Metric Units	Practice measurement of length using British and Metric Systems.
B. Converting Units	Obtain conversion units by measurements followed by calculation.
II. Mass and Weight	Use spring and equal arm balances to measure weights.
	Discussion or reading and report: The differences between mass and weight.
	Compare the weight of a man on the earth with his weight on the moon.
	Use British and Metric Units in simple problems.
III. Force	Discuss the forces commonly found.
	Experiment: Are different amounts of force required to move a body?
	Experiment: Does friction depend upon the nature of the surfaces in contact?
	Discussion or report: Friction—Good and bad effects.
IV. Work	Demonstration and discussion: The force-distance product.
	Have the class use the equipment to obtain several force-distance products.
	Calculate a variety of products using gram-centimetres, ounce-inches, foot-pounds, etc.
	Reading and research: Units commonly used.
	Simple problems.
V. Efficiency	Experiment: To compute input and output work on an inclined plane.
	Discuss results to develop the concept of efficiency.
	Show filmstrip.
VI. Mechanical Advantage	Class activity: Calculate mechanical advantage by measurement of resistance and force and by measurement of distances that force and resistance move.
	Discuss the manner in which friction and machine weight affect the true mechanical advantage.

UNIT I

MACHINES



Aids and References	Understanding and Generalizations
Basic Physical Science, pp. 11-17 *Science, Discovery and Progress,* pp. 7-8, 11-12 *Our Environment, How We Use and Control It,* p. 120	Measurement is basic to all science.
Solar System (Wall Chart)	Mass is a quantity of matter and weight is the result of gravitational force acting on matter.
Basic Physical Science, pp. 18-20 *Science, Discovery and Progress,* pp. 372 *Our Environment, How We Use and Control It,* p. 127	Force tends to produce directed motion or to prevent it. Friction is often a useful force.
Basic Physical Science, pp. 20-24 *Science, Discovery and Progress,* pp. 368-369 *Our Environment, How We Use and Control It,* p. 126	When work is done displacement is in the same direction as the effective applied force.
Basic Physical Science, pp. 24-26 *Science, Discovery and Progress,* p. 373 *Our Environment, How We Use and Control It,* p. 134 Filmstrip—*Energy and Machines*	Work input is normally equal to output of work plus work done to overcome friction; however this generalization is accurate only if the weight of the machine doing the work is disregarded.
	True mechanical advantage can be obtained only by measuring resistance and force when the machine is doing work and calculating the ratio of resistance to force.

UNIT I

MACHINES

Content	Suggested Treatment
VII. Power	Experiment: Measure rate of work using the inclined plane. Develop additional problems to those in the text if required for understanding.
VIII. Simple Machines A. Inclined Plane B. Pulley C. Wheel and Axle D. Screw E. Wedge	Discuss early uses of machines. Each machine should be discussed in a manner to reinforce the concepts of Work, Efficiency, Mechanical Advantage and Power that have been developed. Experiment: Use simple fixed, single, movable and multiple pulleys to further develop the preceding principles. Examine pulleys in common use (block and tackle, wire stretchers). Experiment: Use wheel and axle to further develop the above principles. Report: Various types of wheels and axles. Demonstrate that a screw is a spiralled inclined plane. Work simple problems based on pulleys and wheel and axle (problems on screw and wedge should be used for interest and explanatory value only).
F. Levers 1. Centre of Gravity 2. Moments	Experiment: Balance a metre stick. Discuss the results to develop ideas of moments, clockwise and counter-clockwise rotation, equilibrium. Experiment: Determine the moments of force in the lever using balanced and unbalanced levers. Discuss the results to note effect of machine weight on work done.
IX. Energy A. Kinetic Energy B. Potential Energy C. Transformation of Energy D. Conservation of Energy E. Forms of Energy	Experiment: Transformations of energy in a simple pendulum. Discuss common instances of transformation of potential energy into kinetic energy and kinetic energy into potential energy. Experiment: Can kinetic energy be changed to heat energy? Discuss the changing concept of conservation of energy. Report: Atomic energy and its uses.

UNIT I

MACHINES

Aids and References	Understanding and Generalizations
Basic Physical Science, pp. 26-27 *Science, Discovery and Progress,* p. 370 *Our Environment, How We Use and Control It,* p. 135	Power is the rate of doing work.
Filmstrip—*Simple Machines* *Basic Physical Science,* pp. 30-41 *Science, Discovery and Progress,* p. 371 *Our Environment, How We Use and Control It,* p. 129	Machines may multiply a force, multiply speed or change the direction of a force; they never increase work.
Basic Physical Science, pp. 43-50	The weight of a body acts at its centre of gravity. The turning effect or moment of a force depends upon the distance from the turning point at which the force acts.
Basic Physical Science, pp. 53-59	Energy is the ability to do work.
Science, Discovery and Progress, pp. 6, 15-19	Energy cannot be created nor destroyed.
Our Environment, How We Use and Control It, p. 122	Matter can be converted to energy.

UNIT I
MACHINES

Content	Suggested Treatment
X. Properties of Gases A. Molecules and Matter B. Molecular Speed and Heat C. Molecular Speed and Weight D. Gas Pressure E. Measurement of Gas Pressure	Experiment: Show that gas molecules move. Experiment: Does a gas exert pressure? Discuss the kinetic theory and its relation to pressure. Activity: Construct a barometer and record the readings for several days. Report: Effect of altitude on air pressure. For further class activities to clarify ideas see Lynde—"Science Experiences with Home Equipment".
XI. Properties of Liquids A. Liquid Pressure B. Transmission of Pressure	Demonstration or construction and discussion: Water wheels and turbines; using the weight of water to do work. Experiment: To find the effect of depth on water pressure. Experiment: Is pressure in a liquid transmitted in all directions? Study one or two machines from the following to find out how they make use of these principles—hydraulic jack, lift, press, etc.
XII. Forms of Matter	Activity: Use heat to change sulfur from a solid, to a liquid and to a gas. Discuss results to bring out the characteristics of the forms of matter in terms of the kinetic-molecular theory.
XIII. Machines Using Certain Liquids and Gas Properties A. Lift Pumps B. Force Pumps	Examine models of lift and force pumps. Explain their operation using written or oral language.
XIV. Buoyancy	Experiment: Compare the weight of a body in air with its weight in water. Demonstrate Archimedes' principle. Discuss the applications of the results.

UNIT I
MACHINES

Aids and References	Understanding and Generalizations
Basic Physical Science, pp. 61-68 *Science, Discovery and Progress*, p. 30 *Our Environment, How We Use and Control It*, p. 141	Theories concerning gases are advanced to explain what we see and can be used to predict behavior. Gases exert pressure in all directions.
Basic Physical Science, pp. 70-78 *Science, Discovery and Progress*, p. 194 *Our Environment, How We Use and Control It*, p. 188	Liquids transmit pressure equally in all directions on equal areas.
Basic Physical Science, pp. 78-80 *Science, Discovery and Progress*, p. 6 *Our Environment, How We Use and Control It*, p. 117	
Basic Physical Science, pp. 82-84 *Science, Discovery and Progress*, p. 41 *Our Environment, How We Use and Control It*, p. 148	
Basic Physical Science, pp. 84-86 *Science, Discovery and Progress*, p. 188	Archimedes' Principle: When an object is wholly or partly immersed in a liquid it is buoyed up by a force equal to the weight of the liquid displaced.

SUMMARY OF EXPERIMENTS AND DEMONSTRATIONS FOR UNIT I

1. Are differing amounts of force required to move a body?
2. Does friction depend upon the nature of surfaces in contact?
3. To compute input and output work on an inclined plane.
4. To measure the rate of work using an inclined plane.
5. To show the use of single fixed, single movable or multiple pulleys.
6. To show the use of the wheel and axle.
7. Show that a screw is a spiralled inclined plane.
8. Balance a metre stick.
9. Determine the moments of force in a lever using a balanced or unbalanced lever.
10. Transformations of energy in a simple pendulum.
11. Can kinetic energy be changed to heat energy?
12. Show that gas molecules move.
13. Show that gas exerts pressure.
14. To find the effect of depth on water pressure.
15. Is pressure in a liquid transmitted equally in all directions?
16. Change sulfur from a solid, to a liquid and to a gas.
17. Compare the weight of a body in air with its weight in water.
18. Demonstrate Achimedes' Principle.

UNIT II

COMBUSTION AND FUELS

References:

Hogg: Basic Physical Science, Van Nostrand

J. E. Adair et al: *Science, Discovery and Progress,* Clarke, Irwin & Co.

Van Hooft: *Our Environment, How We Use and Control It,* Allyn & Bacon

Beauchamp et al: *Science Problems, Book I,* Scott Foresman

Beauchamp et al: *Everyday Problems In Science,* Scott Foresman

Brooks and Tracy: *Modern Physical Science,* Henry Holt & Co.

Filmstrips:

How We Get Our Oil (McGraw-Hill)
Petroleum (N.F.B. P-2766)
Fires and Fuels (S.V.E. A491-5)
Coal (C.G.)
Gas (Y.A.F.)
How We Get Our Coal (Y.A.F.)

Films:

Crude Oil Distillation (Shell Oil Co.)
Our Common Fuels (Coronet)
Chemistry of Fire (Available Alberta Civil Defence Office)

Apparatus:

Steel wool
Florence flasks
Glass tubing
Stoppers
Potassium chlorate
Test tubes
Retort stand
Clamps
Alcohol burner
Manganese dioxide
Rubber tubing
Bottles
Water trough
Sulfur
Magnesium
Charcoal
Combustion spoon
Hoffman's apparatus
Sulfuric acid
Iron filings
Candles
Lime water
Bunsen burner
Copper wire
Kerosene
Beakers
Lycopodium powder
Calcium chloride tube
Gasoline
Baking soda
Vinegar
Milk bottle
Excelsior
Alum
Carbon tetrachloride
Coal
Condensing bottle
Blue litmus paper
T-tube
Methyl alcohol
Evaporating dishes
Iodine

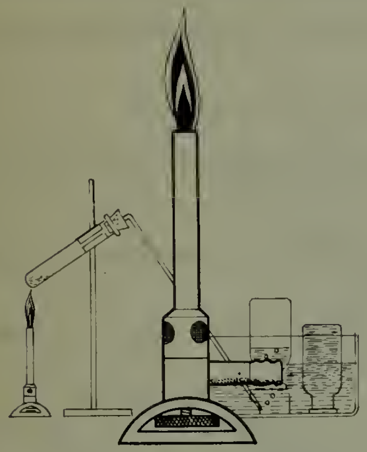
UNIT II

COMBUSTION AND FUEL

Content	Suggested Treatment
I. Oxygen and Hydrogen	
A. Composition of Air	Experiment: The rusting of iron.
B. Elements and Compounds	Discuss the nature of elements and compounds.
C. Oxygen	
1. Preparation and Test	Experiment: Prepare oxygen using potassium chlorate. Test.
2. Catalyst	Experiment: Show that manganese dioxide aids the decomposition of potassium chlorate.
3. A Laboratory Method of Collecting a Gas	Experiment: Collect oxygen.
4. Oxygen and Combustion	Experiment: Burn sulfur in oxygen. Experiment: Burn magnesium in oxygen. Experiment: Burn carbon in oxygen.
5. Oxides	Discuss oxides. Use "word equations" to illustrate.
6. Molecules and Atoms of Oxygen	Discuss molecules and atoms of oxygen. Show briefly the use of symbols in making equations.
7. Types of Oxidation	Using examples, discuss the types of oxidation.
8. Uses of Oxygen	Discuss the uses of oxygen.
D. Hydrogen	
1. Preparation	Experiment: Prepare hydrogen from water.
2. Chemical Reaction	Discuss the burning of hydrogen and formation of water vapor.
II. Fires and Their Control	
A. Candle Flame	Make a diagram showing the parts of the candle flame. Discuss the various zones and the reactions in the candle flame. Experiment: Is carbon dioxide and water vapor formed in a candle flame?
B. Gas Burner	Make a diagram of a Bunsen burner labelling the parts. Discuss the purpose of each part and how the burner works. Experiment: Show that the temperature of a Bunsen flame is higher than the melting point of copper.
C. Household Heaters	Discuss the differences between the Bunsen burner and household heaters such as stoves, furnaces, etc.

UNIT II

COMBUSTION AND FUEL

Aids and References	Understanding and Generalizations
Science, Discovery and Progress, pp. 62-71 *Our Environment, How We Use and Control It,* pp. 57-76	Air is a mixture of gases consisting mainly of nitrogen and oxygen with very small quantities of other gases.
Basic Physical Science, pp. 91-99	Oxygen supports combustion.
	A catalyst may speed up a chemical reaction. Oxygen supports combustion but does not burn. An oxide is a compound of oxygen and another element.
Science, Discovery and Progress, p. 46	Hydrogen burns but does not support combustion.
Basic Physical Science, pp. 100-112	
Science, Discovery and Progress, pp. 75-84	
Science Problems (Book I), pp. 182-223	
Our Environment, How We Use and Control It, pp. 51-56, 62	
Everyday Problems in Science, pp. 72-97	A hydrocarbon is a compound of hydrogen and carbon.
	Exothermic reactions are ones in which heat is given off.

UNIT II

COMBUSTION AND FUEL

Content	Suggested Treatment
D. Matches	Make a diagram of a match. Describe the two types of matches and show their similarities and differences.
E. Kindling Temperature	Explain what is meant by kindling temperature.
	Use examples to show that different substances have different kindling temperatures.
	Experiment: The kindling temperature of kerosene.
F. Dust Explosions	Discuss the causes of dust explosions and how to avoid them.
	Experiment: The burning of a powder.
G. Spontanous Combustion	Explain the cause of spontaneous combustion and what we can do to remedy it.
H. Control of Fire	Discussion on great fires of the past, causes of fires, and methods of control.
	Experiment: Extinguish a gasoline fire by excluding air.
I. Fire Extinguishers	Discuss the purpose of the extinguisher.
	Experiment: Extinguish a candle flame by using carbon dioxide.
	Make a diagram of a soda-acid extinguisher.
	Experiment: Homemade extinguisher.
	Discuss the foamite extinguisher.
	Experiment: Make foamite.
	Discuss the dry carbon dioxide extinguisher and its value.
	Discuss the carbon tetrachloride extinguisher, its advantages and disadvantages.
	Experiment: Can carbon tetrachloride extinguish a fire?
	(Caution: Carbon tetrachloride fumes are dangerous.)
J. Flameproofing	Discuss why flameproofing is necessary, its effectiveness and how it is done.
	Visit your local fire department to find out what is done in your community by way of fire protection.

UNIT II

COMBUSTION AND FUEL

Aids and References

Civil Defence film:

Chemistry of Fire

Understanding and Generalizations

The kindling temperature of a substance is the temperature to which the substance must be heated before it will burn.

Spontaneous combustion is a fire started without the help of an external source of heat.

Fires can be controlled by cooling the burning substance below its kindling temperature, by excluding air, or by removing the fuel supply.

UNIT II

COMBUSTION AND FUEL

Content	Suggested Treatment
III. Coal, A Fossil Fuel	
A. Origin of Coal	Review the origin of coal.
B. Kinds	Discuss the importance of carbon content in determining the kind and hardness of coal.
	Show filmstrip.
C. How Coal is Formed	Explain the actual processes which occur in formation of coal.
	Make graphs showing the percentages of carbon, oxygen, hydrogen and nitrogen in wood, peat, lignite, bituminous coals and anthracite.
D. Location of Coal Fields	Make a map of the world showing important coal fields.
	Make a map of Canada showing important coal fields.
E. Mining of Coal	Discuss the problems encountered in the mining of coal.
	Show filmstrip.
F. Uses of Coal	Discuss the uses of coal as a fuel, in producing electricity, etc.
G. Distillation of Coal	Experiment: The destructive distillation of coal.
	Make a diagram of a coke oven.
	Discuss the processes that go on in a coke oven and the uses of coke.
	Discuss the importance of coal gas and its uses.
	Explain the reaction in a coal gas flame.
	Discuss the importance of coal tar and light oil derived from the distillation of coal.
IV. Oil and Natural Gas	
A. Early Uses	Discuss early uses of oil.
	Make a map of the world showing the major oil fields.
B. The World's Oil Supply	Make a map of Canada showing the oil fields.
C. The Location of Oil	Show filmstrip.
	Review the formation of oil.
	Report: How the geologist attempts to locate oil.
D. Oil Drilling	Report: The drilling for oil.
	Show filmstrip.

UNIT II

COMBUSTION AND FUEL

Aids and References	Understanding and Generalizations
Basic Physical Science, pp. 113-120	Vegetation, under proper conditions first changes to peat, then to lignite, then to bituminous coals, and finally to anthracite.
Science, Discovery and Progress, pp. 76-78 *Our Environment, How We Use and Control It*, pp. 128-135 Filmstrip—*Coal*	
	Coal is formed by the slow decomposition of plant material compressed by overlying strata.
Filmstrip—*How We Get Our Coal*	
	Destructive distillation is the decomposition of a complex substance by heat and the condensation of some of its vapors. Coke, tar, and coal gas are formed in the distillation of coal.
Basic Physical Science, pp. 121-129 *Science, Discovery and Progress*, pp. 597-617 *Modern Physical Science*, pp. 136-148, 154-155	
Filmstrip—*How We Get Our Oil*	The original source of most oil is diatoms. Scientific knowledge and equipment are used in finding oil.
Filmstrip—*Petroleum*	

UNIT II

COMBUSTION AND FUEL

Content	Suggested Treatment
E. Refining Oil	With the aid of a diagram explain how oil is refined.
	Make a chart showing the various fractions of crude oil, condensation temperature and uses of each fraction.
	Show filmstrip.
F. Octane Number	Discuss what is meant by octane number and also discuss its importance.
G. Natural Gas	Discuss where natural gas is found, how it is located, how it is drilled for, and its uses.
	Make a map of Canada locating important gas fields.
	Show filmstrip.
H. Coal, Petroleum and Natural Gas	Discuss the importance of coal, petroleum and natural gas and review the uses of these fuels.
	Make a graph showing the percentage of heat energy supplied by each.
	Show filmstrip.
V. Carbon Dioxide and the Carbon Dioxide Cycle	
A. Carbon Dioxide	
1. Preparation	Experiment: Prepare carbon dioxide.
	Experiment: Test for an acid.
	Explain the chemical reaction of carbon dioxide and water.
2. Test for Carbon Dioxide	Experiment: A test for carbon dioxide.
	Explain the chemical reaction in testing carbon dioxide.
3. Some Properties	Experiment: Pour carbon dioxide on to a candle flame.
	Discuss carbon dioxide's density, and the fact that it is incombustible.
4. Part played in Respiration	Experiment: Compare the amount of carbon dioxide in ordinary air with that in exhaled air.
5. Part played in Photosynthesis	Discuss the importance of carbon dioxide in photosynthesis.
	Experiment: Extract chlorophyll from green leaves. (Caution: Alcohol fumes are dangerous.)
6. Photosynthesis, Combustion	Discuss the part played by carbon dioxide in photosynthesis and combustion.
B. The Carbon Dioxide Cycle	Make a diagram to illustrate the carbon dioxide cycle.
	Discuss this cycle.
C. Carbon Dioxide and Climate	Discuss the long range effect of carbon dioxide on our climate.

UNIT II

COMBUSTION AND FUEL

Aids and References

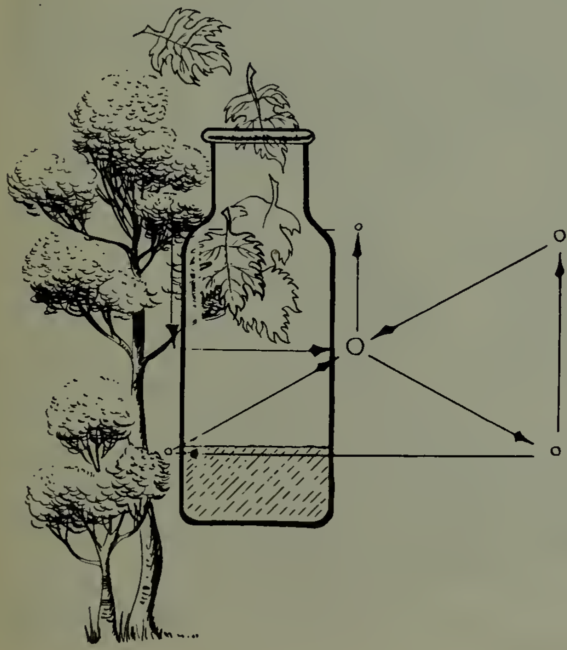
Filmstrips—*Crude Oil Distillation*

Filmstrip—*Gas*

Filmstrip—*Our Common Fuels*

Basic Physical Science, pp. 130-137

Science, Discovery and Progress, pp. 72, 73, and 493-495



Understanding and Generalizations

Many useful products are obtained from crude oil.

Natural gas is the most important fuel gas in industry in North America.

Coal, petroleum, and natural gas are the chief commercial sources of heat energy in Canada today.

Carbon dioxide turns limewater milky.

Carbon dioxide is heavier than air and does not support combustion.

Respiration is an oxidation process.

Any acid will turn blue litmus paper red.

Photosynthesis and combustion are reverse processes.

The circulation of carbon dioxide in nature is called the carbon dioxide cycle.

SUMMARY OF EXPERIMENTS FOR UNIT II

COMBUSTION AND FUELS

1. The rusting of iron.
2. Prepare oxygen using potassium.
3. Test oxygen (prepared above).
4. Show that manganese dioxide aids the decomposition of potassium chlorate.
5. Collect oxygen.
6. The combustion of sulfur in oxygen.
7. The combustion of magnesium in oxygen.
8. The combustion of carbon in oxygen.
9. Prepare hydrogen from water.
10. Find the percentage of oxygen and nitrogen in the air.
11. Is carbon dioxide and water vapor formed in a candle flame?
12. Show that the temperature of a Bunsen flame is higher than the melting point of copper.
13. The kindling temperature of kerosene.
14. The burning of a powder.
15. Extinguish a gasoline fire by excluding air.
16. Carbon dioxide extinguishes a candle flame.
17. A homemade extinguisher.
18. Make foamite.
19. Carbon tetrachloride as a fire extinguisher.
20. The destructive distillation of coal.
21. The destructive distillation of wood.
22. Prepare carbon dioxide.
23. Test for an acid.
24. A test for carbon dioxide.
25. Pour carbon dioxide on to a candle flame.
26. Compare the carbon dioxide in ordinary air with that in exhaled air.
27. Extract chlorophyll from green leaves.
28. Show that starch is formed in photosynthesis.

UNIT III—GRADE IX

HEAT AND TEMPERATURE

References:

Hogg Cross: *Basic Physical Science,* Van Nostrand.

Eubank et al: *Basic Physics,* MacMillan.

Apparatus:

- Metal ball and ring
- Bimetal strip
- Copper tubing
- Aluminum tubing
- Thermostat
- Copper gauze
- Convection current apparatus
- Radiometer
- Heating coil
- Thermos flask
- Clinical thermometer
- Hygrometer
- Potassium permanganate

Determining the composition of water.

UNIT III

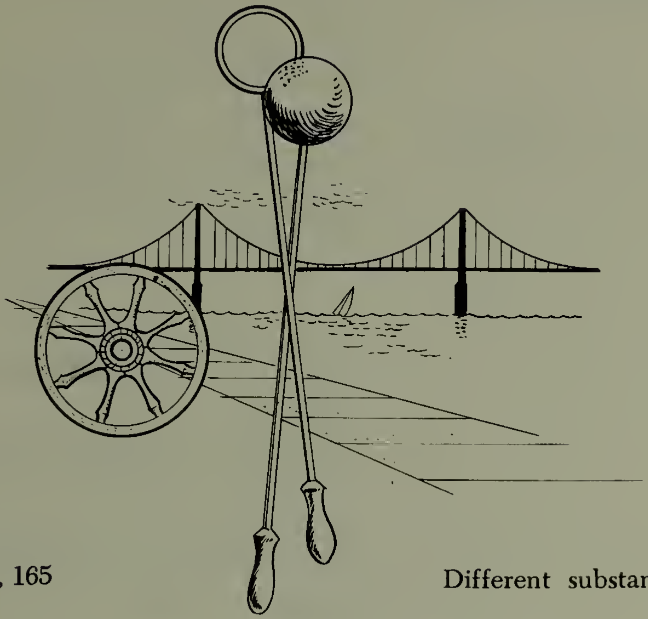
HEAT AND TEMPERATURE

Content	**Suggested Treatment**
I. Effects of Heat	
A. Expansion and Contraction	Common observations:
1. Observations	—Expansion of mercury or alcohol in a thermostat. —Concrete highways, sidewalks, driveways, patios, etc. are laid in sections with spaces between filled with soft asphalt, wood, ten test or similar material. Discuss what would happen if this were not done. —Weathering of rocks (Grade VII). Repeated expansion and contraction. —Steel bridges built in sections with spaces between sections and on rollers. (Interlock fingers), e.g. Golden Gate Bridge (3 feet change). Others—High Level Bridge, Edmonton. C.P.R. bridge, Lethbridge. —Steam pipe construction. —Glass; Why hot water poured into glass jars often cracks them. Pyrex glass, thin glass vessels.
2. The Common Thermostat	What happens to the volume of solids when they are heated? Cooled? Experiments: —Experiment 15-1 (use an aluminum tube, a copper tube, a glass tube). —Ball and ring experiment. —Screw and screw-eye experiment.
3. Molecular Theory	Discussion: "What causes expansion and contraction?"
4. Different Substances and the Expansion Ratio (Coefficient)	Experiment: To loosen a metal screw-cap on a jar. Experiment: Do different metals expand at different rates? (Bimetal strip.)
5. Contraction on Cooling	Observations: Steel tires placed on railroad wheels; iron tires placed on wooden wheels; the use of steel rivets to tie beams together.
6. The Expansion of Liquids	Discuss: The expansion of mercury and alcohol in thermometers; the use of an expansion tank in a hot-water heating system. Experiment: The expansion of water and the difference between water expansion and glass expansion and its effects.

UNIT III

HEAT AND TEMPERATURE

Aids and References	Understandings and Generalizations.
Basic Physics—Experiment No. 1, pp. 115, 164 —Experiment No. 2, pp. 115, 165	Solids generally expand when heated and contract when cooled.
Basic Physical Science, pp. 141-150	The rate and amount of expansion varies with different substances.
Basic Physics, pp. 155, 165	Different substances expand at different rates.



UNIT III

HEAT AND TEMPERATURE

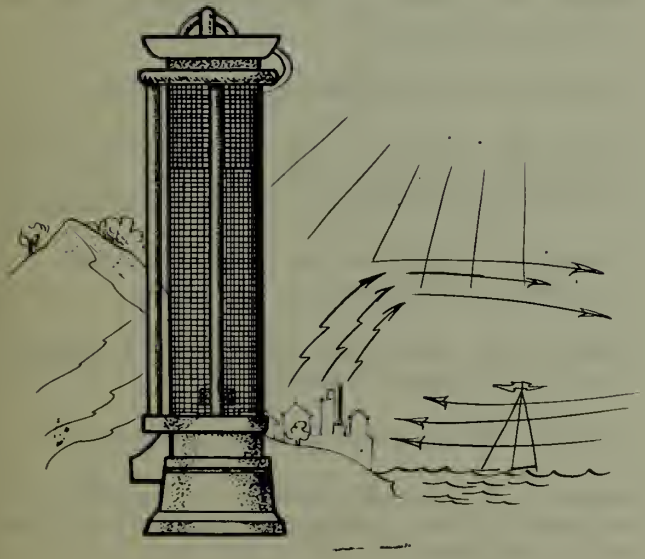
Content	Suggested Treatment
7. Water, a Peculiar Fluid	Why does ice form first at the surface of a lake?
	Discuss what would happen if ice formed at the bottom.
8. The Expansion and Contraction of Gases	Experiment: Construct a simple air thermometer and discuss its operation.
	Experiment: What happens when heat is applied to an inflated balloon?
	Experiment: How does reducing temperature affect the pressure of a gas? (Exp. 15-7).
	Demonstration: The cylinder of an air pump becomes warm as a tire is inflated. Explain.
	When air is allowed to escape from a tire it feels cool. Explain.
II. Transmission of Heat	
A. Conduction of Heat	Review the kinetic-molecular theory and apply it to solids.
	Experiment: The heat conductivity of copper gauze. (Note the safety lamp invented by Davy.)
	Discuss the relative conductivity of wood, cloth, plastic and glass with examples.
	Experiment: Compare the conductivity of wood and copper.
	Experiment: Test water as a conductor of heat.
	Discussion: Discuss gases as conductors of heat and their insulation value for housing, refrigeration, etc.
B. Convection	Demonstration: Hold your hand immediately above a light bulb. What do you notice? Why?
1. Winds, Land and Sea Breezes	Discussion: Why do we have winds? Why do we have land and sea breezes?
	Discuss the relation of high and low barometric pressures to winds.
2. Convection Currents in Water	Demonstration: Show that convection currents operate in water and explain the reasons.
	Demonstration: The operation of a hot-water system.
C. Radiation	Discussion: The transfer of energy through space by radiation rather than by the motion of molecules.
	Experiment: Show that heat from a metal ball is evident below the ball.

UNIT III

HEAT AND TEMPERATURE

Aids and References

Basic Physical Science, pp. 151-161



Understanding and Generalizations

Water expands when it freezes and becomes lighter volume for volume.

Gases expand when heated and contract when cooled.

Gases heat when compressed and cool when expanded.

Some materials conduct heat well. Others are poor conductors.

Winds are caused by convection currents which set air in motion. This is a flow of molecules.

Convection may occur in liquids and gases.

Heat travels through a partial vacuum by means of radiation.

Radiant energy from the sun sustains life on earth.

UNIT III

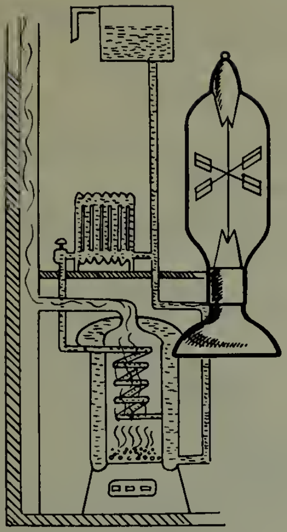
HEAT AND TEMPERATURE

Content	Suggested Treatment
D. Absorption of Heat	Observations: —Dirty snow melts faster than clean snow. —Dark clothing is warmer in summer than light colored clothing. —Compare the temperature of the inside of a car with a light-colored top with that of one with a dark-colored top. Experiment: Use a radiometer to show the effect of absorption and radiation.
E. The Distribution of Heat	Discussion: Heating systems in houses or other buildings and the use of convection currents, radiation and conduction for the purpose of distributing heat.
III. Temperature	
A. Theory of Temperature	Discuss the fact that molecules move faster as they are heated.
B. Measurement of Temperature	
1. Touch	Experiment: Is touch a reliable measure of temperature?
2. Fahrenheit Thermometer	Demonstration: Set up an air thermometer, devise a scale to go with it and try to measure temperature with it. Discuss the history of the development of the Fahrenheit thermometer. Establish how the fixed points were decided.
3. The Centigrade or Celsius Scale	Discuss the history of the development of the Centigrade thermometer and the scale that was devised. Establish the fixed points. Discuss advantages. Experiment: Check the fixed points on both Fahrenheit and Centigrade thermometers.
4. Compare Fahrenheit and Centigrade Temperatures	Compare the relationship between 1 Centigrade degree and 1 Fahrenheit degree. Show how the conversion formulas are derived. Problems: Do enough problems to facilitate the conversion of any temperature reading from one scale to the other.

UNIT III

HEAT AND TEMPERATURE

Aids and References



Basic Physical Science, pp. 162-171

Understanding and Generalizations

Good absorbers of radiant energy are good radiators or emitters of it.

Poor absorbers of radiant energy are poor emitters of it.

Heating systems make use of convection, radiation and conduction to distribute heat.

Temperature is a measure of the movement of the molecules of a substance.

There are two commonly accepted scales for measuring temperatures.

UNIT III

HEAT AND TEMPERATURE

Content	Suggested Treatment
5. Measuring Body Temperature	Establish that normal body temperature of humans is 98.6° F. but that this may vary.
	Discuss the limits for health.
	Discuss the modern ways of maintaining comfortable temperatures in a home.
	Discuss the difference between warm and cold-blooded animals.
6. Special-purpose Thermometers	Examine a clinical thermometer and a meat thermometer.
	Discuss the automatic oven type of thermometer found in some stoves.
7. Mercury as a Thermometer Liquid. Alcohol as a Thermometer Liquid.	List the advantages and disadvantages of using mercury and/or alcohol as a thermometer liquid.
8. Low and High Temperatures	Discuss the uses of low and high temperatures.
	Establish the meaning of absolute zero.
	Discuss the temperatures of air, the sun, melting points of various substances, etc.
9. The Use of Color as an Indication of Temperature	Discuss the use of a pyrometer as a measurer of temperature.
	Experiment: Show that the temperature of a Bunsen burner varies at different points.
IV. Heat A. What is Heat?	Establish that substances may indicate the same temperature but because of size or quantity they may contain different amounts of heat.
B. Measurement of Heat	Establish the units of heat: 1. Btu; 2. Calorie.
	Establish the relation between 1 Btu and 1 calorie.
	Problems: Do enough problems to establish good understanding.
C. Heat Capacity of Substances	Discussion: Do land and water masses absorb the sun's heat at the same rate?
	Experiment: Compare the heat capacity of water and sand.
D. Heat from the Sun	General discussion and review of the effects of the heat from the sun.
	Discussion: The solar furnace; solar house heating.

UNIT III

HEAT AND TEMPERATURE

Aids and References

Basic Physical Science, pp. 172-179

Understanding and Generalizations

Human life depends upon the maintenance of a narrow range of body temperature.

Many animals have a much greater temperature tolerance than man.

There are many ways of measuring temperature.

The type of measurement depends upon the range of temperature to be measured.

Temperature depends on the average speed of the molecules of a substance.

Heat depends on the number of molecules as well as their speed.

Nearly all energy comes from the sun.

UNIT III

HEAT AND TEMPERATURE

Content	Suggested Treatment
E. Heat of Combustion	Set up tables showing calorie content of fuels and foods.
V. Evaporation of Liquids	Demonstrate evaporation and discuss the principles involved.
A. Cooling effect of Evaporation	Experiment: What happens to temperature when evaporation takes place?
B. Rate of Evaporation	Explain why evaporation occurs more rapidly in some cases than in others. Experiment: Do all liquids evaporate at the same rate?
C. The Water Cycle	Review.
D. Refrigeration	Experiment: Make ice by evaporation. Discuss.
E. Boiling	Experiment: Boil water and observe the successive steps involved.
1. Observations	
2. Pressure	Relate barometric pressure to boiling point at various altitudes. Experiment: Boil water under reduced pressure. Discussion: How long does it take to hard boil eggs at various places in Alberta, in the mountains, at sea-level?
3. Boiling Point at Increased Pressure	Experiment: How does the pressure cooker solve the problem of altitude?
F. Latent Heat of Vaporization	Establish the fact that the temperature of boiling water does not rise above 100° C. at sea-level and additional heating only increases the rate at which bubbles are released from the liquid. Show that steam and boiling water are at the same temperature. Discussion: The storing of latent heat during vaporization, and its release during condensation. Discussion: How steam heating uses the vaporization-condensation cycle.
G. Relative Humidity	Explain the terms: —Humidity. —Relative Humidity.

HEAT AND TEMPERATURE

Aids and References

Basic Physical Science, pp. 180-190

Understanding and Generalizations

Fuels and foods, each releases a definite calorie content when oxidized.

The rate of evaporation depends on the particular liquid in question.

Evaporation causes cooling.

The boiling point of a liquid is the temperature at which its vapor pressure equals the pressure of the atmosphere.

Water boils at different temperatures at different pressures.

A pressure cooker not only solves the cooking problems at high altitudes but it greatly reduces the time of cooking at any altitude.

Latent heat of vaporization is the heat that changes a liquid to a vapor without changing the temperature.

Latent heat of vaporization is stored in a vapor till the vapor condenses.

$$\text{R.H.} = \frac{\text{water vapor actually present in the air}}{\text{maximum amount possible at that temperature}}$$

UNIT III

HEAT AND TEMPERATURE

Content	Suggested Treatment
	Discuss the effect of temperature change on relative humidity.
	Experiment: Use an hygrometer to find the relative humidity of the air in the classroom.
	Discuss the relationship between:
	—Relative humidity and health.
	—Relative humidity and comfort.
H. Dew Point	Discuss why dew often appears on the grass in the evening or morning.
	Experiment: Fill a beaker with cold water. Observe and explain the presence of moisture on the outside of the beaker. Relate your observation to dew point.

UNIT III

HEAT AND TEMPERATURE

Aids and References

Understanding and Generalizations

Dew point is the temperature at which moisture begins to condense from the air.

SUMMARY OF EXPERIMENTS AND DEMONSTRATIONS FOR UNIT III

HEAT AND TEMPERATURE

1. What happens to the volumes of solids when they are heated?
    - (a) Expansion of a copper rod.
    - (b) Ball and ring experiment.
    - (c) Screw and screw-eye experiment.
2. To loosen a metal screw cap on a jar.
3. Do different metals expand at different rates?
4. The expansion of water and the difference between water and glass expansion and its effects.
5. Construct a simple air thermometer.
6. What happens when heat is applied to an inflated balloon?
7. How does reducing temperature effect the pressure of a gas?
8. The cylinder of an air pump becomes warm as a tire is inflated. When air is allowed to escape from a tire it feels cool.
9. Try the heat conductivity of copper gauze.
10. Compare conductivity of copper and wood.
11. Test water as a conductor of heat.
12. Hold your hand above a light bulb.
13. Show that convection currents operate in water.
14. How does a hot water system operate?
15. Show that heat from a metal ball is evident below the ball.
16. Use a radiometer to show the effect of absorption and radiation.
17. Is touch a reliable measure of temperature?
18. Set up an air thermometer and devise a scale to go with it.
19. Check the fixed points on both Fahrenheit and Centigrade thermometers.
20. Use a clinical thermometer.
21. Show that the temperature of a Bunsen burner varies at different points.
22. Compare the heat capacity of water and sand.
23. Demonstrate evaporation.
24. What happens to temperature when evaporation takes place?
25. Do all liquids evaporate at the same rate?
26. Make ice by evaporation.
27. Boil water.
28. Boil water under reduced pressure.
29. Use a pressure cooker.
30. Use an hygrometer to show relative humidity.
31. Condensation of water vapor.

UNIT IV—GRADE IX

LIGHT

References:

Hogg: *Basic Physical Science,* Van Nostrand

Adair et al: *Science, Discovery and Progress,* Clarke, Irwin & Co.

Burns et al: *Physics—A Basic Science,* Van Nostrand

Grolier Society: *The Book of Popular Science*

Beauchamp et al: *Science Problems No. 3,* Scott Foresman

Filmstrips:

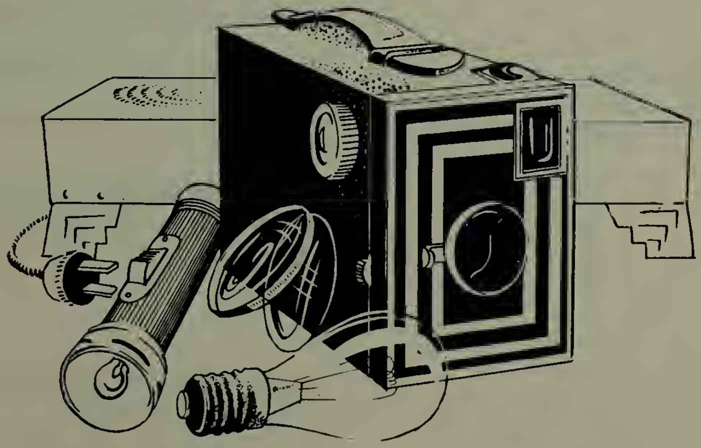
Light and Its Characteristics (Curriculum) ($5.00)

The Eye and Optical Appliances (Curriculum) ($5.00)

The Telescope and Science (Curriculum) ($4.80)

Apparatus:

- Carbon sticks
- Burette clamps
- Asbestos strips
- Insulated wire
- File
- Fluorescent tube
- Flashlight
- Lens—Concave and Convex
- Florence flask (large)
- Box camera
- Strontium chloride
- Sandpaper
- Electric Hot Plate
- Support stands
- Light bulb (200 watt clear glass)
- Magnifying glass
- Small mirrors
- Prism
- Mirrors—Concave and Convex
- Roll of photographic film
- Bunsen or alcohol burner
- Copper chloride



UNIT IV

LIGHT

Content	Suggested Treatment
I. Illumination	
A. Sources of Light	Short review of the history of light.
1. Carbon Arc	Experiment: Make a carbon arc.
2. Carbon Filament	Discuss filament lamps.
3. Tungsten Filament	Experiment: Examine an incandescent lamp.
	Note behaviour of tungsten filament in air.
4. Vapor Lamp	Experiment: Light from gases.
	Discuss types of lights utilizing gases and examine actual fixtures.
	Enrichment Suggestion: Construct a model of an incandescent lamp.
	Read and do experiments.
II. Light and Effects	
A. Reflection of Light	Experiment: Reflect light from a mirror and note light paths.
1. Image in a Plane Mirror	Experiment: To show the position of the image in a plane mirror
2. Mirror Images Reversed	Show filmstrip.
	Discuss laws of reflection, using diagram to illustrate.
B. Refraction of Light	Experiment: Seeing over edge of dish by refraction.
	Experiment: Law of refraction.
	Illustrate refraction by diagrams.
C. Lenses	Discuss concave and convex lenses.
	Experiment: Use a convex lens to concentrate the rays of the sun.
	Enrichment Suggestions: Read further and do additional experiments, excluding mirrors and lenses.
III. Optical Instruments	
A. A Simple Camera	Examine a simple box camera and discuss its principles of operation.
B. The Eye	Make a diagram of the eye and show the similarity between it and the camera.
	Show filmstrip.

UNIT IV

LIGHT

Aids and References

Basic Physical Science, pp. 193-198

Book of Popular Science, Vol. 9, pp. 3761-3776

Science, Discovery and Progress, pp. 269-273

Book of Popular Science, Vol. 6, pp. 2411

Book of Popular Science, Vol. 8, pp. 3083-3085

Basic Physical Science, pp. 199-206

Physics, A Basic Science, pp. 273-300

Filmstrip—*Light and Its Characteristics*

Science Problems No. 3, pp. 173-193

Book of Popular Science, Vol. 8, pp. 3085-3088

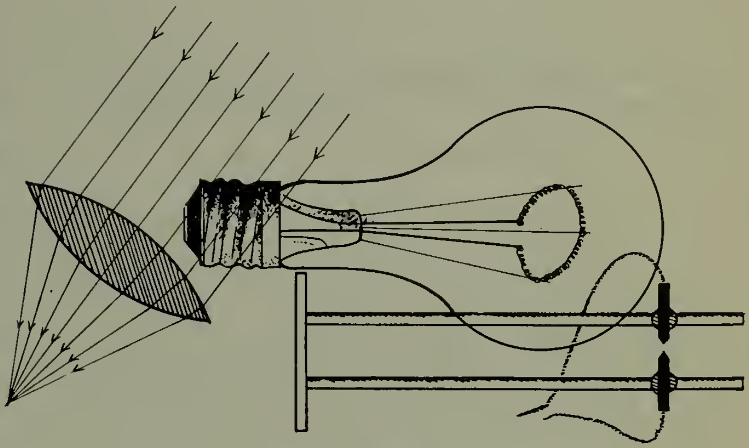
Basic Physical Science, pp. 207-216

Physics, A Basic Science, pp. 303-307

Filmstrip—*The Eye and Optical Appliances*

Understanding and Generalizations

When the need arose man discovered methods of producing artificial light. The search for more effective methods has never ceased.



It has been possible to formulate laws concerning the behaviour of light since its effects occur in a systematic manner under similar conditions.

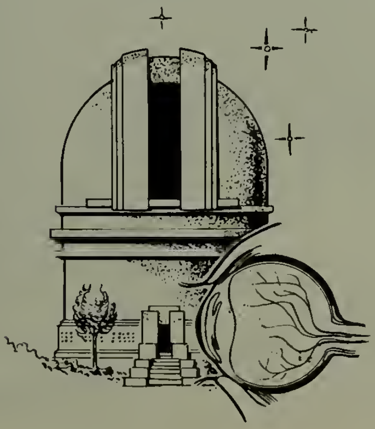
UNIT IV

LIGHT

Content	Suggested Treatment
C. The Telescope	Discuss types of telescopes and telescopic photographs.
	Report: The Palomar Telescope.
	Show filmstrip.
	Enrichment Suggestion: Make a pinhole camera.
IV. Color	Discuss the nature of color.
A. Spectrum	Experiment: Formation of a spectrum.
	Discuss the rainbow.
B. Colors of Objects	Experiment: Colors of objects illuminated by light of different colors.
1. Color of Sky	Discuss variation in color.
2. Color of Sunset	Discuss reason for coloring.
3. Color and Safety	Report on choice of colors.
C. Light Waves	Discuss light travel and wave length.
1. Heat and Color	Discuss wave lengths and heat.
2. The Spectroscope	Report: The spectroscope.
a. Infrared Light	Report: Infrared light and its uses.
b. Ultraviolet Light	Report: The ultraviolet light band.
Electromagnetic Spectrum	Report: Radio waves, gamma rays and the x-rays.
	Enrichment Suggestions: Read further on x-rays. Do experiments with color listed in references.

LIGHT

Aids and References	Understanding and Generalizations
Physics, A Basic Science, pp. 311-314	Knowledge of the ways in which light behaves made possible the invention of lenses which in turn made possible the invention of many modern optical instruments.
Filmstrip—*Telescope and Science* (Carr)	
Book of Popular Science, Vol. 8, p. 3086	
Basic Physical Science, pp. 217-228	White light is composed of a combination of colors occurring in the visible spectrum.
Science, Discovery and Progress, pp. 250-262	
Physics, A Basic Science, pp. 325-330	
	Color is the result of partial absorption and consequent subtraction of one or more colors from the spectrum.
Physics, A Basic Science, pp. 261-264	Beyond the limits of the visible spectrum there are wave lengths that are invisible. Ultraviolet waves and the infinitely short waves of cosmic rays occur at the violet end of the spectrum, and the infrared waves of heat and the long waves of radio are found at the red end of the spectrum.
Physics, A Basic Science, pp. 320-323	
Physics, A Basic Science, pp. 496-497	Man has made use of wave lengths beyond the limits of the visible spectrum.
Book of Popular Science, Vol. 7, pp. 2681-2688	
Book of Popular Science, Vol. 8, pp. 3088-3090	



SUMMARY OF EXPERIMENTS FOR UNIT IV

LIGHT

1. To make a carbon arc.
2. Examine an incandescent lamp.
3. Light from gases.
4. To reflect light from a mirror.
5. To show image in a plane mirror.
6. Law of refraction.
7. To look over edge of dish by means of refraction.
8. Concentrate the rays of the sun, by means of convex lens.
9. To show formation of a spectrum and the rainbow.
10. To show how colors of objects change under different lights.

UNIT V—GRADE IX

TRANSPORTATION

References:

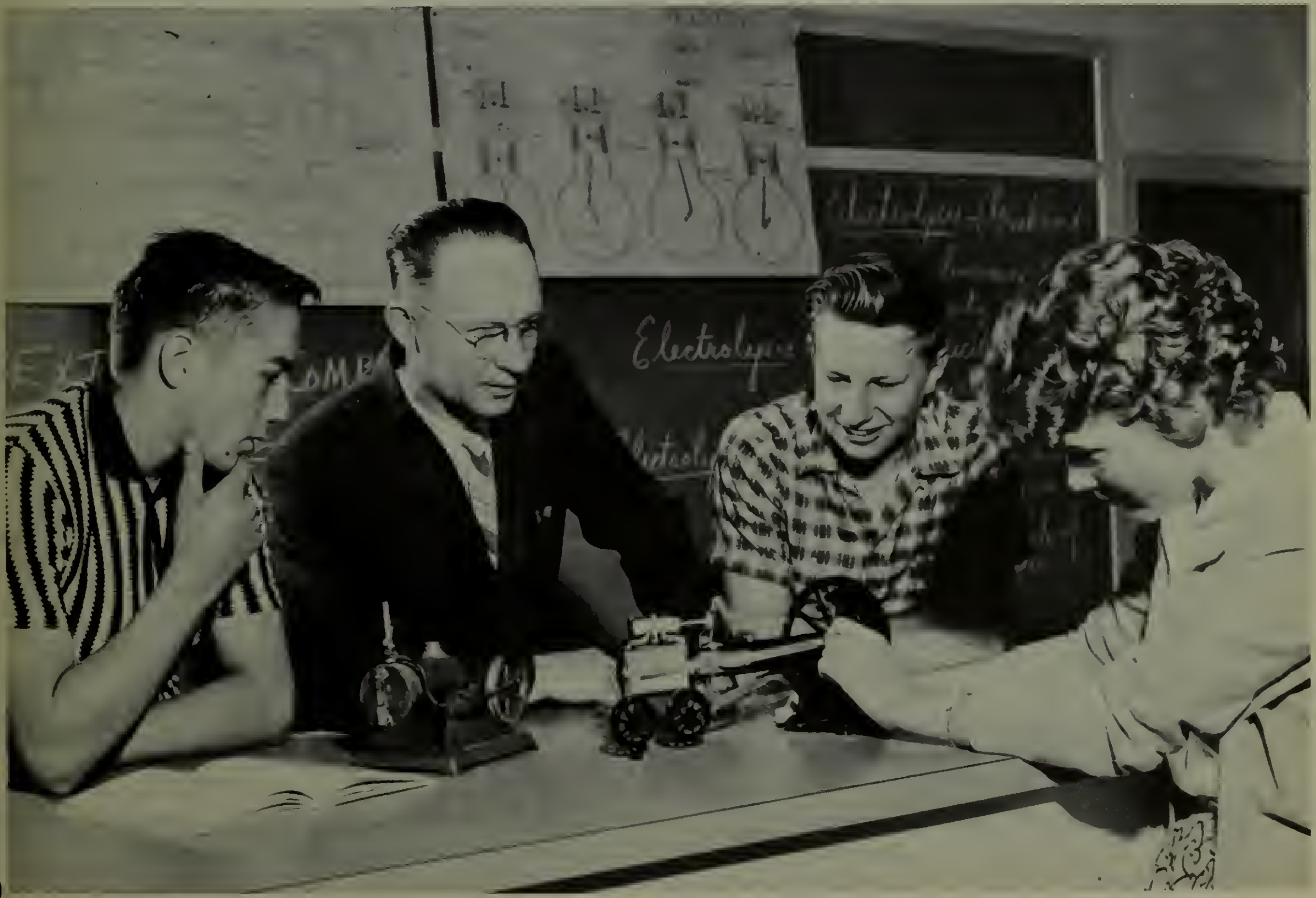
Hogg & Cross: *Basic Physical Science,* Van Nostrand

Adair et al: *Science, Discovery and Progress,* Clarke, Irwin & Co.

Van Hooft: *Our Environment, How We Use and Control It,* Allyn & Bacon

Apparatus:

- Model steam engine
- Rubber tubing
- Glass tubing
- Test tubes
- Induction coil
- Spark plug
- Venturi tube
- Model gasoline engine



Experimenting with model steam engines

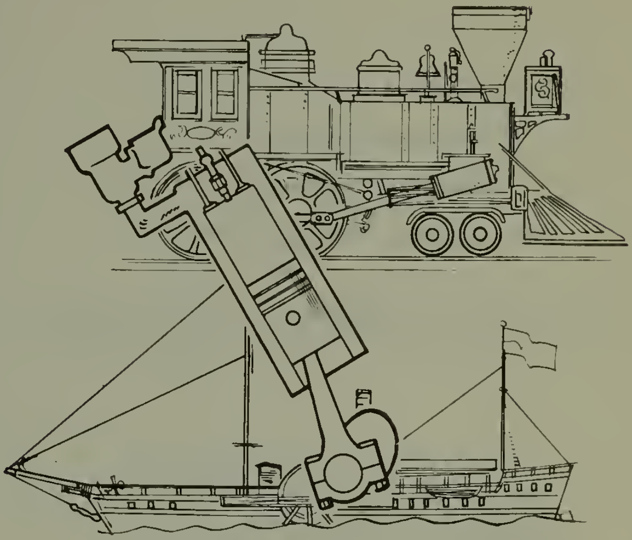
UNIT V

TRANSPORTATION

Content	Suggested Treatment
I. Steam Engines	
A. Reciprocating Engines	Reports on the early steam engine and its uses: Watt, Trevethick, Cugnot, Stephenson, Fulton, etc.
1. Newcomen	Experiment: Show the expansive force of steam.
2. Watt	Examine a toy steam engine to note the parts and principles of operation with oral and/or written explanations.
3. Steamships	Make a report with diagrams on the slide-valve steam engine.
4. Locomotives	Report: Heat losses in the steam engine.
5. The Cylinder	
6. Efficiency	
B. Steam Turbines	Experiment: Show how a steam turbine operates.
1. Working Principles	Reading and Report: Advantages of the steam turbine.
	Compare turbines and reciprocating engines.
C. Transmission of Power	Examine bicycles, appliances, toys, etc. Note use of belts and gears.
1. Belts and Gears	Construct belt drives and gear trains using Meccano or other construction media.
II. Internal Combustion Engines	Demonstrate the principle of the carburetor.
A. Vaporization of Fuel	Examination of a carburetor to note the parts.
1. Bernoulli Effect	Make oral and/or written explanations and diagrams.
B. Gasoline Engines	Use models or preferably an old motor to note the parts and explain their operation.
1. Four Cycle Engines	Make oral and/or written explanations with diagrams.
2. Transmission of Power	
a. Crankshaft and Flywheel	Have pupils report on power transmission. Avoid detail in summary.
b. Clutch	
c. Transmission	Have pupils give reports with diagrams.
d. Differential	
C. Diesel Engines	
1. High Compression Engines	Report or discussion: Comparison of the gasoline engine and the diesel engine.
2. Four-stroke Diesels	
3. Two-stroke Diesels	Use models or small glo-plug type airplane motors to explain two-stroke principles.

UNIT V

TRANSPORTATION

Aids and References	Understanding and Generalizations
Basic Physical Science, pp. 231-234	When a substance is heated the energy of the molecules is increased.
Science, Discovery and Progress, pp. 406-407	
Our Environment, How We Use and Control It, p. 351	
Basic Physical Science, pp. 234-236	
Science, Discovery and Progress, p. 407	
Our Environment, How We Use and Control It, p. 354	
Basic Physical Science, pp. 236-238	
Science, Discovery and Progress, pp. 385-386	
Basic Physical Science, pp. 240-241	
Science, Discovery and Progress, p. 410	
Our Environment, How We Use and Control It, p. 355	Chemical energy can be used to do work.
Basic Physical Science, pp. 241-248	
Science, Discovery and Progress, p. 410	
Our Environment, How We Use and Control It, p. 361	
Basic Physical Science, pp. 248-250	Compression produces heat; this enables a high compression engine to burn low-grade fuel.
Our Environment, How We Use and Control It, p. 359	High compression engines are more efficient than gasoline engines.

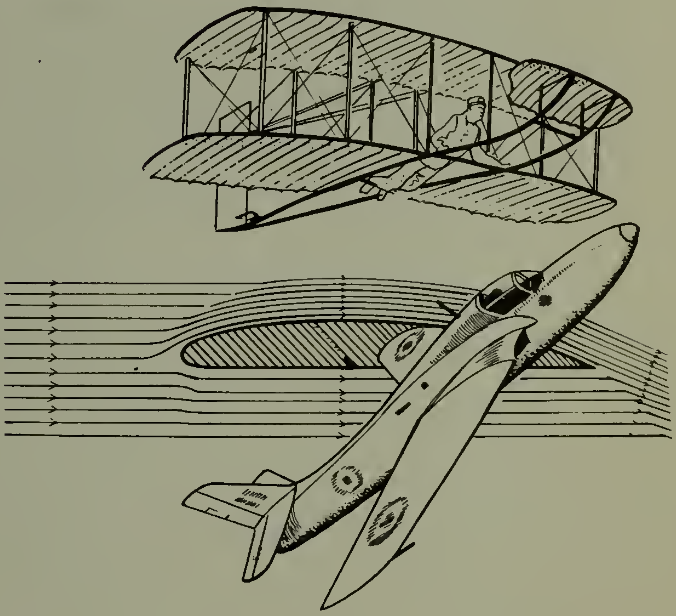
UNIT V

TRANSPORTATION

Content	Suggested Treatment
III. Aircraft	
	Pupil reports: Brief review of the history of flight.
A. Bernoulli's Principle	Experiment: Show the Bernoulli effect.
	Experiment: Show the lift effect of an air stream.
	Pupil reports: Lift effect of an air stream on airplane wing.
B. Components of a Force	Discuss simple examples of force components.
1. Horizontal Component	
2. Vertical Component	
C. Lift and Drag Forces in Flight	Discuss, with diagram, the forces acting on an airplane.
D. Newton's Third Law	Demonstrate Newton's Third Law using a paper or balsa glider.
	Examine the control surfaces on a model airplane.
	Discussion or report with diagrams: Controlling flight.
E. Jet Propulsion	Experiment: Show flight due to reaction.
1. Simple Jet Engines	
IV. Jets, Rockets and Missiles	
A. Gas Turbines	
1. Sound Barrier	Discuss and report.
2. Contrast with Reciprocating Engines	Diagram study.
3. Turbo-prop and Turbo-Jet	Collect materials from current magazines and newspapers.
B. Ram Jet	
C. Rockets	
1. Basic Principles	New material in this area is being published constantly; it is wise to start a file for such material early in the year.
2. Rocket Motors	
D. Missiles	
1. Powering	
2. Fuels	
3. Controls	
a. Guided Missiles	
b. Ballistic Missiles	
E. Artificial Satellites	**Enrichment: This area offers a great deal of scope for reading and exploration.**

UNIT V

TRANSPORTATION

Aids and References	Understanding and Generalizations
Basic Physical Science, pp. 252-260 *Science, Discovery and Progress,* pp. 47-51, 52-53 *Our Environment, How We Use and Control It,* p. 382	Bernoulli's Principle: The pressure within a fluid in motion is lower than the pressure outside the stream; and the greater the speed of the stream the less the pressure within it.
	Newton's Third Law: For every action, there is an equal and opposite reaction.
Basic Physical Science, pp. 262-275 *Science, Discovery and Progress,* pp. 51, 208	
	As man increases his speed and range of travel many new scientific problems must be met and solved.

SUMMARY OF EXPERIMENTS AND DEMONSTRATIONS FOR UNIT V

TRANSPORTATION

1. Show the expansive force of steam.
2. Show how a steam turbine operates.
3. Demonstrate the principle of the carburetor.
4. Show the Bernoulli effect.
5. Show the lift effect of an air stream.
6. Demonstrate Newton's Third Law using a paper or balsa glider.
7. Show flight due to reaction.

Enrichment Reading List

Le Roi, David: *Radar, Radio and Television,* Jet Propulsion and Rocket Power, Clarke, Irwin & Co. Ltd., Toronto.

Grolier Society: *Book of Popular Science.*

Bradley, F. M.: *Solar Energy,* Thomas Crowell Co., New York.

Ahnstrom, D. N.: *Complete Book of Jets and Rockets,* World Publishing, New York.

Thomas, Henry: *Thomas A. Edison,* Putnam & Sons.

De Camp, Sprogne: *Engines,* Golden, New York.

McCormick: *Atoms, Energy and Machines,* Creative Educational Society.

Pratt, Fletcher: *All About Rockets and Jets,* E. M. Hale & Co.

Evans, W. W.: *Petroleum,* Clarke, Irwin & Co. Ltd., Toronto.

Rolt, L. T. C.: *Motor Cars,* Clarke, Irwin & Co. Ltd. Toronto.

Lynch, Patrick: *Man Makes His World,* MacMillan Company of Canada, Ltd.

Braun, Whipple and Ley: *Conquest of the Moon,* MacMillan Company of Canada, Ltd.

Gordon and Scheer: *First Into Outer Space,* MacMillan Company of Canada, Ltd.

Bausch and Lomb Optical Co., Rochester 2, New York:

Milestones in Optical History.

Depth of Focus.

Experiments Using the 3D Microscope.

Filmstrip List and Publishers

How We Get Our Oil, McGraw Hill Co.

Petroleum (P-2766) N.F.B. (National Film Board).

Fires and Fuels (A491-5) S.V.E. (Society for Visual Education, Inc.).

Coal, C. G. (Common Ground).

Gas and *How We Get Our Coal,* Y.A.F. (Young America Films).

Light and Its Characteristics; The Eye and Optical Appliances; Energy and Engines; The Telescope and Science, Curriculum.

Simple Machines, E.B.F. (Martin Photo Ltd., 350 Donald Street, Winnipeg 2, Manitoba).

Supplementary Filmstrips List

Bernouilli's Principle, Jam Handy.

Visual Sciences—*Light; Heat,* Suffern, New York.

Work and Heat Energy; Transference of Heat, Keystone View Co., Meadville, Pa.

Introduction to Energy, Y.L.P. (Johnson Brothers, 5512-20th N.W., Seattle 7).

Engine Series No. 585-590, Curriculum (Johnson Brothers, 5512-20th N.W., Seattle 7).

Crude Oil Distillation; Hydraulics (T-87), Shell Oil Co.

Our Common Fuels, Coronet.

Molecular Theory of Matter, Encyclopedia Brittanica.

Note: For addresses see Grades VII, VIII Science Guide.

List of Apparatus, Equipment and Chemicals for the Grade IX Science Laboratory

1. **Equipment**
    - Test tubes
    - Beakers
    - Funnels
    - Flasks
    - Glass tubing
    - Graduates
    - Thistle funnels
    - Watch glasses
    - Calcium chloride tube
    - Bunsen or alcohol burners
    - Retort stands
        - rings
        - burette clamps
    - Test tube brushes
    - Spring balance
    - Balance and weights
    - Cork borers (set)
    - Stoppers
        - rubber
        - cork
    - Test tube racks
    - Pneumatic trough
    - Bottles
    - Filter paper
    - Litmus paper
    - Rubber tubing
    - Iron wire gauze
    - Mortar and pestle
    - Crucible tongs
    - Prisms
    - Meter sticks
    - Steel wool
    - Test tube clamps
    - Candles
    - Evaporating dishes
    - Copper Wire—bare and insulated
2. **Chemicals**
    - Acids—HCl, H_2SO_4, HNO_3
    - Sodium chloride
    - Calcium chloride
    - Manganese dioxide
    - Sulfur
    - Magnesium
    - Charcoal
    - Iron filings
    - Lime water
    - Kerosene
    - Gasoline
    - Baking soda
    - Vinegar
    - Alum
    - Carbon tetrachloride
    - Lycopodium powder
    - Alcohol (denatured)
    - Iodine crystals
    - Mercury
    - Potassium permanganate
    - Strontium chloride
    - Copper chloride
    - Coal
3. **Tools**
    - Triangular file
    - Hammer
    - Screw driver
    - Pliers, regular
    - Pliers, long nosed
    - 6" adjustable wrench

Special Material for Grade IX

- Friction block
- Inclined plane board and attachments
- Pulleys—single
    - double
- Wheel and axle
- Clamp and support for meter stick
- Pendulum bob
- Mercury barometer tube
- Archimedes' Principle apparatus
- Model jack screw
- Model hydraulic press
- Model lift pump
- Model force pump
- Combustion spoon
- Hoffman's apparatus
- Condensing bottle
- T tube
- Milk bottle
- Excelsior
- Copper tubing (2 feet)
- Aluminum tubing (2 feet)
- Metal ball and ring
- Bimetal strip
- A used thermostat
- Copper gauze
- Composite rod (2' of ½" diameter copper tubing and wood doweling)
- Convection current apparatus
- Radiometer
- Heating coil
- Hygrometer
- Thermos flask
- Carbon sticks
- Sandpaper
- Asbestos strips
- Electric hot plate
- Light bulb—200 watt clear glass
- Magnifying glass
- Fluorescent tube
- Small plane mirrors
- Flashlight
- Lenses—concave and convex
- Mirrors—concave and convex
- Roll of photographic film
- Box camera
- Model steam engine
- Model gasoline engine
- Induction coil
- Spark plug
- Venturi tubes

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